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ADVOCATING THE HISTORY OF SCIENCE

ABSTRACT

Everett Mendelsohn has advised candidates for the Ph.D. degree to go out to Harvard Square and explain their dissertation. That it is important to communicate with an audience is one message. That we, in the academy, should take our knowledge to society, is another. That is one use of scholarship, and has been a driving force in Everett's career. Everett founded the *Journal of the History of Biology* in 1968 and edited it for 31 years, and he trained several generations of historians of biology. Indeed, he was instrumental in founding the field. It is therefore appropriate to ask: what do we gain by studying the history of biology and the history of science generally? This paper explores answers to that question. History of science helps make science better and helps make us better citizens. In effect, this is an argument for the promotion of history of science in the public interest.

When I was growing up in Oak Ridge, Tennessee, it seemed clear what social responsibility the scientist had. He (usually "he") should go to the lab in the morning wearing a suit, work all day, then come home and leave his work behind. After all, it was privileged knowledge (not that we called it that) with a top security clearance. Certainly it was not something to be shared with families, as the billboards at the edges of town reminded everyone with their exhortations to "sssh ..." and "protect American security". This all seemed perfectly normal, and soon the atom really would produce energy "too cheap to meter". Atomic bombs were effective deterrents to war, and besides, my dad was head of the peaceful and friendly neutron physics division. Pure science, right? Promoting the public good, right? Was I naïve? Yes. Was this comfortable and reassuring? Yes. Surrounded by all this lovely science, there seemed to be no question that my brother and I would become scientists too.

Then my freshman year at MIT in 1968–1969 brought a tumult of challenges. Against the backdrop of the Vietnam War, leading scientists offered a day-long "teach-in" to discuss "science in the public interest" and "the social responsibility of the scientist". One after another, these eminent scientists

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challenged the easy assumptions that scientists have a license simply to pursue their "pure science", leaving it to a presumably responsible public to decide on appropriate uses. They all accepted J. Robert Oppenheimer's lament that "scientists have known sin" and set out to debate what followed from that realization. What should a socially responsible scientist do? What did it even mean to be "socially responsible", much less a "socially responsible scientist"? Heady stuff for a college freshman, and I don't pretend to have gone very far at the time in thinking it all through. But up Massachusetts Avenue at Harvard, Professor Everett Mendelsohn had already embarked on a long career of trying to make sense of the history of science, and of what that history tells us about the meaning of social responsibility.

Everett's brand of social responsibility has focused on promoting world peace, especially through his decades of work with the American Friends Service Committee. Fortunately, Harvard has afforded him the support necessary to carry on that service while sustaining his academic life. He has managed to bring these interests together through courses that explore the social context and the social nature of science – even before it was trendy to do so. Through his editorial ventures, he has encouraged scholars to publish social analyses of science. In the History of Science Department, Everett has nurtured interest in social responsibility at many levels.

Cambridge served as a visible center for Vietnam War protests and advocacy for political change, with some scientists playing important roles in accepting and even leading the challenges. Cambridge also became a center for lively debates about the social responsibilities of biologists through Matthew Meselson's widely-acknowledged concern with biological and chemical weapons; and again, as recombinant DNA research provoked new concerns about safety and science. Issues of racism and IQ, and the need to temper an excessive genetic determinism that can serve as justification for racism and other social inequities, have likewise placed Cambridge at the center of debate. Everett has played a part in many of these discussions.

It is easy among academic liberals to point to one side of these various issues and to applaud advocates' courage in taking a stand for what they believe is right. Indeed, most discussion of the "social responsibility of the scientist" has assumed that we know what is right, and has focused on how active and social a role the scientist should play in effecting the presumed proper and just position. In the Cambridge context, the Vietnam War was bad, most war is bad, biological and chemical warfare is bad, genetic engineering is at least potentially bad, racism is bad, sexism is bad. While these views seemed defensible and widely shared in academia, they are not all universally held and are not often held simply by virtue of being a scientist.

This brings us to questions about the appropriate social role of the scientist: is it to do good science, or also to be a good scientist in some wider sense and to raise social issues insofar as they derive from scientific work? In this case, the developmental biologist might say "please notice that I have made it possible to clone humans, and you people should figure out the ethical issues". Or is it, even further, to serve as a public intellectual and to take positions of presumed

social good more generally: "I have invented cloning techniques and urge you not to use them for cloning people"? What social responsibilities arise by virtue of being a scientist, and what responsibilities arise by virtue of being an educated citizen? These are complex questions with a multitude of conflicting interpretations. While traditional liberalism would have us focus on rights and associated responsibilities, other political doctrines emphasize the obligations of contracts, or the needs of the presumed existence of community or absolute normative truths. Thus, people can – and do – disagree about what ideas and responsibilities particular players have in the social order. This is often difficult for academic liberals to accept. In their often-isolated realm, they believe that they know what is good and right, all the while calling for inclusion of a babble of diverse voices and "stories". Indeed, some attempts to call for "tolerance" in the name of political correctness have foundered upon the reality that some views and some behaviors are intolerable.

My intention is not to discuss social and political theory, however, but rather to acknowledge the verifiable fact that social responsibility of scientists has been an important category of interest for many, including Everett Mendelsohn. Everett's career pushes us to think about this more carefully. I want to consider a special aspect of that discussion, asking about the social role of the *historian* of science. Not the social responsibility, because I do not have compelling grounds for claiming any moral imperative or clearly defined responsibility. Rather, I wish to look at the social opportunity offered the historian of science. And for those who accept that there is responsibility, realizing this opportunity will be a moral good. For others, it may be pragmatically and politically, as well as socially, expedient for reasons that I will discuss. I contend that the historian (and the philosopher) of science has valuable, socially useful knowledge. This is knowledge about what science is, how it works, what forces change science over time, and its past significance and value. The historian of science has insight, perspective, and information in the form of examples and generalizations that can shape the way society thinks about science and its products. Historians of science can help inform social decision-making and can help guide the process by which we adjudicate competing and conflicting claims. In other words, I am claiming for historians of science a sort of "privileged knowledge", much as my father had, although we can and should share it. I quite realize that some will find such claims objectionable. But please note that I am not claiming for historians of science the sole right of arbitration or the ultimate or only valuable knowledge. Rather, historical knowledge can enlighten and improve our social decisions in ways open to multiple sets of values and goals. I will outline some examples before offering suggested audiences for history and philosophy of science. I will explore especially the value for promoting public understanding of science, informing science education, and advancing social goals.

Promoting the Public Understanding of Science

With few exceptions, we accept public understanding of science as a good thing. We can argue about what this really means, about how much understanding is best, about who qualifies as the public and such things, but only the most extreme science bashers would resist the abstract goal. There have been times when elitists have argued that the public did not need science and was better kept in the dark, but with the accepted public support of science in this century, this reasoning has virtually disappeared. While there are questions about the legitimacy and risks of secrecy in particular cases, the dominant view in recent decades has been that we should tear down the barriers, and teach the public about science and its power. In the post-Sputnik era, we generally assume that scientists are necessary to do good things, and that the public should have access to this work.

So, given that the public understanding of science is a good thing, who should promote it, and how? In part this should take place in the schools, through science education, though we do not always do this or do it well. We also need a wider effort addressed at adults, going beyond the schools to reinforce and extend the message outside academia. Science – and technology – serve as a central force of change for society, and increasingly many decisions will be based on scientific claims. Assuming that we would rather make wise and informed choices when we have the option, we need for at least the decision-makers to have some understanding of the science on which the issues and their decisions must be based.

For example, Members of the United States Congress (and apparently every other country's leaders) make many decisions about science and based on science. Yet only two members of the United States House of Representatives are Ph.D. scientists, although there is also a handful of physicians and people with related technical degrees. The one Ph.D. historian of science, Bob Filner (Democrat from San Diego), has focused on Veterans issues that dominate his district, rather than directly on science. Yet some have suggested that at least half the votes in Congress either require scientific knowledge or directly influence the doing of science. Since Congressmen are not scientists themselves, they must rely upon others for expertise – either their personal staffs (few of whom are trained as scientists, and many of whom openly admit that they tried to avoid science courses in college), committee staffs (and even in the House Science Committee, many do not have any scientific training), lobbyists (who have their own goals, although some, such as Research!America, lobby for all biomedical scientific research) or nonprofit organizations (well-intentioned, though often incomplete and directed at some particular, selected set of political goals).

The experience of serving as science advisor for my Congressman for the two years of the 105th Congress (1997–1998) was instructive. The Congressman representing the university district approached our College of Liberal Arts and Sciences, from which he had graduated as an English major with fluency in Mandarin Chinese. A first term conservative Republican who supported Newt

Gingrich's "Contract with America", he was appointed to the House Science Committee. He came, asking how he could learn from the many scientists working at the Research I university in his district. Significantly, he wanted to avoid making unwise decisions that would antagonize the university and its scientific core. So, Arizona State University developed a plan to place a faculty member "on assignment" to work with him, while also developing projects and information of value to the university. The university agreed to pay salary, travel costs and living expenses in Washington, D.C. Both the Congressman and the university preferred someone with broad scientific interests, and preferably a senior faculty member, with the understanding that the person should remain politically neutral. That was how I came in.

Technically, I became a Congressional Fellow and in that role served as Congressman Matt Salmon's science advisor. I was not really "staff" in the usual sense – assigned to cover a particular set of my own issues – but instead worked with all the regular government employees on issues related to science, technology, research, and education. This was a tremendous learning experience for me and also, evidently, for the Congressman. And here is the point of this story: my status as an historian and philosopher of science was important in gaining credibility because I was not seen as serving any one narrow or particular political or academic interest (this is, in part, for the rather depressing reason that nobody thinks of history and philosophy of science as being a field important enough to have interests to be served). Someone who reflects upon science more generally, and someone willing to work at communicating about what is at issue in a range of particular cases asks about ways to go about making decisions informed by past experience, using the best available present knowledge – that was what everyone wanted. Being a senior faculty member and older (and more liberal) than anybody else in the office, (including the Congressman) provided an amusing twist at times, and gave me credibility that I might not otherwise have had – as long as I was eager to listen and learn as well as to teach.

Historians of science have special opportunities to play roles as Congressional Fellows. Other historians of science who have served as Fellows (Ron Overmann, who worked with Senator Mitchell from Maine, and Rivers Singleton, who worked with the late Congressman George Brown of California) agree that we have special opportunities in this area. Indeed, when I met Congressman Brown, who had chaired the Science Committee with distinction for the Democratic majority, he immediately asked "why are you working with Matt Salmon? Why aren't you working with me?" He said that he would like an historian of science in his office to provide perspective. (Unfortunately, Congressman Brown, a great supporter of science, has died recently and will be greatly missed). Congressman Vernon Ehlers (a Republican physicist from Michigan) agrees that professionals with a wider view of the sciences, and those willing to learn, are indispensable for informed and intelligent decision making – and are all too rare. Let us look at some differences we can make.

On several occasions, a heated topic provoked lively and partisan discussion. Cloning was such a case, in which the immediate reactions were shaped by

analogies with fertility cases, complete with the fears and misunderstandings that all reproductive issues bring. Hearings invoked parallels with fetal tissue and abortion, cited fears of "throw-away" humans cloned to harvest body parts, and enthused about cloning as a solution to the world's infertility problems. An historical perspective could have been helpful, by placing research into a larger context, and clarifying what is really new and what an appropriate response might be. History could have defused the initial hysteria, while also showing that there are questions deserving serious debate. Similarly, historians could have contributed depth to the President's National Bioethics Advisory Committee (NBAC) report, which had an unfortunate tendency to treat every issue as if it were completely and drastically new.[1] Discussions at the American Association for the Advancement of Science (AAAS), the National Academy of Sciences (NAS), and other sites of science in Washington brought a calming effect as they began to place cloning in perspective. Historians gave science writers a framework, and the *New York Times* called upon the history of embryology from the 1920s and 1930s in its presentation of the new results.[2] Who ever thought the long-deceased embryologist Hans Spemann would make the front page of the *Times*? This larger perspective began to influence Congressional staff who, recognizing the complexity of the case, backed off from restrictive legislation. They even backed away from Congressman Ehlers' modest bill which would have limited federal funding for human cloning if the goal were to create a human being.[3]

Another Congressional example shows the history of science very directly and actively at work. Metropolitan Life Insurance Company was concerned about lawsuits with potentially far-reaching liability consequences for scientists, academic institutions, and those who insure them. One lawsuit sought to hold researchers liable for the consequences of their research – even when it was others who had adopted their results. The lawsuit contended that researchers should have known better, obviously did bad science, and should therefore be held accountable. The underlying assumption was that scientists should know better, and should only publish that which is true for all time. Thrown out on technicalities, the suit alerted MetLife to potentially expensive and far-reaching problems. They hired Lindley Darden, historian and philosopher of science at the University of Maryland, to produce a summary paper explaining how science works. She made clear that what is perfectly good science one day, given the constraints of the time, should be *expected* to give way to other results. This does not mean that the work was bad, but rather that things simply change – as they should, indeed, as we would be surprised if they did not. Darden outlined several examples of Nobel Prize winners and other scientific leaders whose work was later supplanted.[4] Science, while fallible, is self-correcting over time. A Congressional hearing discussed Darden's presentation. Darden's academically unorthodox assignment had impact, and made a real difference. There are other such opportunities, and we should accept them when they arise. This does not mean that every individual must take on such tasks every time, but collectively we should view such opportunities as being integral to our profession. We should then carry them out with

as much dedication as Lindley Darden and Everett Mendelsohn have brought to the task.

The AAAS, as the world's largest umbrella organization for general science, coordinates efforts to promote the public understanding of science in the United States, especially in Washington, D.C. Through its science policy directorate, the AAAS coordinates a Congressional Fellows program, provides training for academics to work effectively with Congress and the federal government, and helps scientists and science policymakers alike to interpret the workings of science. Interestingly, Albert Teich not only heads the policy directorate of the AAAS, but also oversees the AAAS archives, and recognizes the importance of the history of science. The AAAS reaches a wider audience through *Science* and other publications and on-line products, its annual award for public understanding of science, its mass media fellowship program, and other activities. Advancing science by promoting public understanding is what the AAAS is about, and we historians can work with the AAAS to keep a broader historical perspective on science.[5]

Educating about Science

Science education has been a significant public concern in the United States since Sputnik jolted Americans from their post-war complacency. The Third International Mathematics and Science Study (TIMSS) results released over the past few years have brought this concern to the fore once again.[6] Virtually everyone agrees that we must do something about science education, but there is considerable disagreement about what that something should be, who should do it, and who should pay. Is education a matter for federal or state control? Should we set and enforce standards for everybody, or just some? Who should set and enforce these standards? How do we reach prospective students, teachers, and others to effect improvement in curricula textbooks, and classrooms?

While every relevant agency or organization now wants to play a role, the AAAS became an early and strong leader through two complementary programs. The Education and Human Resources Directorate, headed by biologist Shirley Malcom, promotes science education for all Americans. Based on the conviction that education produces strong citizens, and that scientific and technical education produces a strong workforce, Malcom has focused on providing access to science through partnerships with schools, black churches, Girl Scouts, science centers, government agencies, and other nonprofit organizations – wherever there is sufficient willingness, energy, and enthusiasm to generate optimism and results. The Peabody Award-winning radio adventure show "Kinetic City Science Supercrew" makes clear the message: "Science is fun!" Along with "Bill Nye the Science Guy" and his television show, the AAAS provides the best inspiration available in America for students and teachers.

Another AAAS program, Project 2061, provides the framework, guidelines, and resources for teachers to develop curricula and to improve classroom

instruction in science, while also outlining goals and examples for textbook writers. *Science for All Americans,* which appeared as the first volume of a series in 1990, explains that "Education has no higher purpose than preparing people to lead personally fulfilling and responsible lives". It goes on to explain that science education "should help students to develop the understandings and habits of mind they need to become compassionate human beings able to think for themselves and to face life head on".[7] James Rutherford, director of the project, worked with physicist/historian Gerald Holton, and consulted a number of historians of science from 1985 through a second (*Benchmarks*) and third volume (*Resources*).[8] All three volumes stress the goal of cultivating scientific "habits of mind" and promoting "scientific ways of knowing" for all. Science is a process, and it changes over time. Historical examples demonstrate this scientific process, while depicting scientists as normal human beings and not (necessarily) as supernerds. Historians of science have played – and I argue, ought to play – valuable roles by contributing to such projects.

Of course, historians are not always going to be invited to assume these roles, so we need leaders to serve as public intellectuals, making clear how important the historical perspective is for science and policy-making. And to continue making that point, as often as possible and even when it seems like talking to an empty room. Eventually, someone will hear. We must contribute to the formulation of National Research Council (NRC) reports on science and science education, for example, and accept invitations to comment on such reports. Several of these projects have produced stronger results because of their historical input, and a larger number (including the National Science Foundation (NSF) report on undergraduate education, "Shaping the Future") would have been more effective had they been given a larger historical perspective.[9] As biologist/educator Anthony Lawson notes, "the history of science has much to offer in terms of helping us identify 'natural' routes of inquiry, routes that past scientists have taken and routes that present students can also take – routes that should lead to scientific literacy. That is, to students who know what science is and how to do it".[10]

To frame better how we think about science, historians could point to Thomas Henry Huxley's views on science education. In an after-dinner speech on science education in 1869, Huxley noted "that no boy or girl should leave school without possessing a grasp of the general character of science, and without having been disciplined, more or less, in the methods of all sciences; so that, when turned into the world to make their own way, they shall be prepared to face scientific problems, not by knowing at once the conditions of every problem, or by being able at once to solve it; but by being familiar with the general current of scientific thought, and by being able to apply the methods of science in the proper way ...".[11] Or we might point to a century-old address by geologist Sir Archibald Geike to students of science. Observing that only a few would achieve jobs in their scientific fields, and that most would likely end up doing things other than scientific research, Geike argued: "To those who may ultimately be thus situated it will always be of advantage to have had the mental training given in [the sciences], and it will probably be your own fault if, even

under unfavorable conditions, you do not find, from time to time, chances of turning your scientific acquirements to account".[12]

The point is not that there is eternal recurrence, or that the more things change, the more ... they don't. Rather, we need to be more aware of the deep underlying factors shaping how things work throughout time. That "cutting edge" that we hear so much about must cut something blunted by years of tradition and experience. And the cutting tools will be sharper if we understand the evolving context and patterns of change.

Adults also need science education. Since the *Daubert v. Merrell Pharmaceuticals, Inc.* ruling by the U.S. Supreme Court, for example, judges have been officially responsible for selecting experts to adjudicate among competing scientific claims in the courtroom.[13] Historians can help, as Jan Witkowski has shown effectively in his program for federal judges at Cold Spring Harbor Laboratory's Banbury Conference Center. Judges, who often come from a political science or history background, typically have relatively little scientific training. The historical perspective they receive from experts in science and the history of science actually makes the scientific claims they sort through more accessible and less intimidating. Since the *Daubert* decision makes judges more legally responsible for understanding the technical and scientific content of their cases, this accessibility has become increasingly important. Science-trained "experts" should be available and willing to serve judges, as well as plaintiffs and defendants – despite what is likely to be minimal pay.

Another example: Disney needs technical experts for their movies and for the "Edu-tainment" business. Why not historians of science, who can bring in truly bizarre examples from past science? Museums, science centers, and zoos all can benefit, though most of them do not yet realize it. So we have to educate them all. An opportunity for historians of science lies in educating and creating a market for historical thinking about science. How can we know what is "cutting edge" today if we have no sense of where we have been and in what direction the edge might be pointed now? Historians know that science is not simple. We know that it is dangerous to claim that science always makes progress, or that we can unfailingly tell what is cutting edge at any given time, and we must use our knowledge to advance realistic science education, based on science as science really is done. We want neither a vision of science-as-savior nor an acceptance of a science-less demon-haunted world.[14] We can help to ensure that superstition does not always – or ever easily – win out over science.[15] We should help to promote a realistic view of science as a process, undergoing change, carried out by real people, and always in a context of values, constraints, and opportunities.

One final example. Recently, an Arizona Board of Education-appointed committee sought to keep references to "evolution" out of the state's science standards. Our courageous State Superintendent of Public Instruction, Lisa Graham Keegan, led the Board in deciding that each member would appoint a representative to a special review committee. Ultimately, the presence of an informed historian of science, working closely with an evolutionary biologist, carried the day on that review committee, and successfully crafted a set of

standards that brings evolution back into the science standards. This was accomplished by acknowledging that what we know now may change in response to new evidence and argument. The process, carried out in a civilized and respectful way that kept returning to the historical examples, demonstrated that political give and take can sometimes work to produce the "right" results.

The state Board and its well-intentioned public officials did not know how to include evolution in a non-controversial way, and they were happy to let an historian draft the state standards and to suggest questions for state-mandated proficiency tests. And here, both the historical perspective embraced in AAAS's Project 2061 and the concrete suggestions of the National Research Council's report on teaching evolution were very helpful.[16] Once again, the lesson is that, in cases where historians have the opportunity, we need those who will accept the challenge. Equally important, we need department chairs, administrators, and colleagues who will not devalue those who assume such roles and serve the public interest by contributing to committees, serving on school boards, running for office, or playing a range of administrative and popularizing roles. If we all insist upon sitting in our ivory towers and pontificating about the academic virtues of remaining insulated from the murkiness of the real world, then (1) there will be fewer of us, and (2) we will be making a mockery of all that the history and philosophy of science shows about how knowledge is produced.

Advancing Social Goals

While there is room for disagreement about which social goals deserve attention, some have achieved universal acceptance. Some of these are based on scientific principles or historical claims in which historians and philosophers of science can play specific roles in espousing the "right" view, or debunking unjustified claims. Two different examples are racism (and by analogy, sexism and other forms of discrimination based on unsubstantiated claims about biological differences and destiny), and freedom of speech. I raise these together.

A rich literature has emerged in the history of science surrounding the roles played by women, and politicized views of gender. Even more attention has been paid by historians of science to racism—and the use of science in promoting and legitimizing racism.[17]

Historians of science played a valuable role when Hernnstein and Murray's *The Bell Curve* appeared in 1994. Several scholars, including African-American geneticist-historian Joseph Graves, pointed out what was wrong with their warmed-over statistical manipulations and underlying assumptions.[18] Others pointed to the authors' history of controversy and showed that the new offering was not very new. At around the same time, Graves, a group of his students, and historian of science Bonnie Blustein used historical evidence and argument to show that J.P. Rushton's racist poster presentation on presumed differential racial IQ (which he had injected into a AAAS annual meeting by changing

what he had originally proposed and the AAAS had accepted) was part of a continuing campaign to justify racism on pseudo-scientific grounds. Robert Proctor's close studies of Nazi eugenic practices and their underlying "scientific" claims afford another example of an historian's clarifying why scientific claims are sometimes problematic.[19] Racism flies in the face of the best available scientific evidence now, but other historians show that this has not always been true. Therefore, claims of racial differences in IQ, and in other traits and behaviors are based on appeals to other sets of values. Historians help to demonstrate this. And they help to remind us to remain skeptical and not to be seduced by the exaggerated claims that have lured people into supporting false doctrine in the past.

In each case, historians have shown how particular examples fit into a larger historical pattern. They have shown what constitutes a legitimate scientific claim and what is disputed and therefore an illegitimate basis for social action. In cases like these, they are able to say "this is wrong because it is based on an indefensible foundation". By accepting the opportunity to speak out, even if going beyond their own particular specialized expertise to draw on the collective knowledge of the professional community, they have made a difference.

I am not suggesting that historians have a special claim to insight on every issue. Of course, many claims are not illuminated by examples from the history of science. In these cases, both the interests of science (which depend upon the free exchange of scientific ideas) and the interests of a democracy in protecting free speech, call for caution. (It is not appropriate for anyone to shout down others because of disagreements over views that are reasonably held, for example.) And it is certainly not acceptable to do so in the name of science. There have been such examples – rare, but troubling examples.

The most widely-cited example was that of biologist E.O. Wilson, who met an infamous reaction at a AAAS meeting in the mid-1970s. Some tried to keep him from speaking, and one person doused him with water while he spoke. His opponents argued that his sociobiological ideas, based upon genetic determinist assumptions, were "wrong", socially unjust, hence immoral. Perhaps these accusations were valid, (although I would not condone attempting to stifle someone's speech when we ought to listen to his case and argue it on the basis of evidence and logic). But here we have disagreements over values. Some critics went on to claim that we know by virtue of studying the history of science that Wilson's work is "bad". I deny that we knew that it was bad in this moral sense in 1975, when his *Sociobiology* first appeared.[20] In fact, the history of science shows a pattern of dispute about genetic determinism and biological causation of traits and behaviors, that demonstrates its social, political, and moral motivations. We do not know enough to know how much is genetically-driven, and can only express preferences or beliefs about what the outcome will be. When we know much more, we can only know in many cases that we prefer – for extra-scientific reasons – to have one outcome over another.

In its context, Wilson's view was neither surprising, nor was it "bad" science. Neither were the alternatives. Historians of science know that. So historians

might have legitimately poured water on the protestors' heads as well as on Wilson's, if the point was that his claims were not scientifically "proven", and that the social implications mattered. But, then, we would be pouring a lot of water on a lot of heads because, as we know, much of science is tentative. As the history and philosophy of science show, it takes time to adjudicate among competing claims. The history of science argues for tolerance and for embracing a range of views at any given time, then providing a rich context in which they can play out. It should not make quick judgements, nor produce social or moral claims in the name of science that the policy process seeks.

This discussion is part of the fuss about science studies and the so-called "science wars". Neither Wilson nor James Watson nor . . . whoever should make exaggerated social claims in the name of their sciences, any more than historians and philosophers of science should make exaggerated social claims. The long view, carefully considered, is desirable. We should make decisions as informed as possible.

Conclusion

While overzealous attempts to silence those who disagree with any given view are bad, utter silence is far worse. We have an excellent opportunity to speak out about how science works, to develop our scholarship, and to show what conclusions follow from recognized patterns and processes of change.

Everett once said that, in order to receive a Ph.D. degree, every student should have to explain his or her thesis to someone in the street around Harvard Square. I heard him say this in the 1970s, and at the time I thought it was cheating to choose Harvard Square. Nonetheless, the point about communication is well taken, and holds for the entire field. I would not argue that every student, in order to be a "card carrying" historian of science, must go to the head of NSF or a Congressman and explain how science works and why history matters. But I would argue that it is vitally important for the continued good of the community and for the public generally that historians of science do this. To make a difference requires that we value those who do so. We must reward rather than marginalize, emulate rather than decry and teach graduate students that social action, on issues where we act by virtue of our scholarship, is good and important. We must explain why, when, where, and how history matters in order to understand why, when, where, and how science matters.

There is also pragmatic value in this form of increased influence, jobs, and new niches for historians of science. We can – and should – do better for our students than fight among ourselves for the few academic positions in the United States. Positions in honors or interdisciplinary studies programs also exist, and we can argue that we, or our students, can fill those jobs. They will do better if we help prepare them with broader perspectives. Some find opportunities to work with government and education administrators. Some of these opportunities call for established senior scholars to step up and take the lead. Senior scholars often have the resources to help everyone in the field, and thus benefit the community and the profession as a whole.

If we do not engage in this discussion, others will. There are many who are only too willing to do so. Wilson has offered to subsume all natural science and social science into "consilience" based on genetic determinants.[21] Neither allowing him to be the only spokesman on issues of social behavior and morality, nor just dropping water on his head, is effective social action. We have an opportunity, and an argument can be made that not to exercise such an opportunity is a moral failure. If we do speak out, we can make a difference.

Rather than engaging in science wars, let us seek cooperation and understanding through effective communication. Along the way, we will create more opportunities. And as a result, we can help to promote the legitimate social goals of peace and social responsibility – as Everett inspires us to do.

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NOTES

[1] National Bioethics Advisory Committee, "Cloning Human Beings". June 1997 U.S. Government report. See website at <http://www.bioethics.gov/pubs.html>.

[2] Michael Specter with Gina Kolata, "After Decades and Many Missteps, Cloning Succeeds", *New York Times*, March 1997, pp. A1 and A8. Also see follow-up: Gina Kolata, *Clone: The Road to Dolly, and the Path Ahead* (New York: William Morrow and Co., 1998).

[3] See legislative bills proposed during the 105th Congress, including House Resolution (HR) 922 and 923.

[4] Lindley Darden, "The Nature of Scientific Inquiry", March 30, 1998. Discussed at a House Science Committee hearing and available on her website at: <http://www.inform.umd.edu/EdRes/Colleges/ARHU/Depts/Philosophy/homepage/faculty/LDarden/sciinq/>.

[5] Sally Gregory Kohlstedt, ed., Michael M. Sokal, Bruce V. Lewenstein, *The Establishment of Science in America: 150 Years of the American Association for the Advancement of Science* (New Brunswick: Rutgers University Press, 2000).

[6] National Science Board, Task Force on Mathematics and Science Achievement, "Preparing Our Children. Math and Science Education in the National Interest", March 1999. On TIMSS, see especially, *A Splintered Vision. An Investigation of U.S. Science and Mathematics Education*, William H. Schmidt, Curtis C. McKnight, Senta A. Raizen, eds. (Dordrecht: Kluwer, 1997); and William H. Schmidt et al., *Facing the Consequences. Using TIMSS for a Closer Look at U.S. Mathematics and Science Education* (Dordrecht: Kluwer, 1999).

[7] AAAS Project 2061, *Science for All Americans* (New York: Oxford University Press, 1990), p. xiii.

[8] AAAS Project 2061, *Benchmarks for Science Literacy* (New York: Oxford University Press, 1993); *Resources for Science Literacy*,(New York: Oxford University Press, 1997).

[9] Melvin George, chair, "Shaping the Future. New Expectations for Undergraduate Education in Science, Mathematics, Engineering, and Technology", National Science Foundation, 1996.

[10] Anthony Lawson, "What Should Students Learn About the Nature of Science and How Should We Teach It?", *Journal of College Science Teaching* (May 1999), pp. 401–411, quotation p. 411.

[11] Thomas Henry Huxley, "Scientific Education: Notes on an After-dinner Speech", in *Science and Education Essays, Collected Works*, Vol. III (London: Macmillan, 1869, 1893), pp. 111–133.

[12] Archibald Geikie, "Science in Education", an address to students at Mason University College, Birmingham, *Nature*, 59, 1898, pp. 108–112.

[13] See Daryl E. Chubin, Edward J. Hackett, and Shana Solomon, "Peer Review and the Courts, or When Scientists 'Get Real'", *Accountability in Research*, 4, 1994, pp. 1–8.

[14] Carl Sagan, *The Demon-Haunted World. Science as a Candle in the Dark* (New York: Random House, 1997).

[15] John Burnham, *How Superstition Won and Science Lost* (New Brunswick: Rutgers University Press, 1987).

[16] National Academy of Sciences, Working Group on Teaching Evolution, National Academy of Sciences, "Teaching About Evolution and the Nature of Science" (Washington, D.C.: National Academy of Sciences Press, 1998).
[17] Some of the best examples that address racism are Stephen Jay Gould, *The Mismeasure of Man* (New York: W.W. Norton, 1996); and Kenneth R. Manning, *Black Apollo of Science. The Life of Ernest Everett Just* (New York: Oxford University Press, 1984).
[18] Richard J. Hernnstein and Charles Murray, *The Bell Curve. Intelligence and Class Structure in American Life* (New York: Free Press, 1994); Joseph L. Graves and T. Place, "Race and IQ Revisited: Figures Never Lie, But Often Liars Figure", *Sage Race Relations Abstracts*, 20, 1995, pp. 4–50.
[19] Robert N. Proctor, *Race Hygiene: Medicine Under the Nazis* (Cambridge: Harvard University Press, 1988).
[20] Edward O. Wilson, *Sociobiology* (Cambridge: Harvard University Press, 1975).
[21] Edward O. Wilson, *Consilience. The Unity of Knowledge* (Cambridge: Harvard University Press, 1998).